Original Article

Effect of Light Conducting Cylindrical Inserts on Gingival Microleakage

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Abstract:

Objective: Microleakage in the gingival floor of class II composite restorations can compromise the marginal adaptation of the filling material to the cavity edges. The aim of this study was to evaluate the effect of light conducting cylindrical inserts in decreasing the microleakage of the gingival floor in cavities 1mm below the CEJ.

Materials and Methods: Eighty maxillary first molars were randomly divided into eight groups according to use of glass inserts, type of resin (Coltene unfilled resin versus Scotchbond multi purpose) and filling technique (one-unit versus incremental). Proximal class II cavities were prepared in all samples with the gingival floor one millimeter below the CEJ. Etched and silan-treated glass inserts were made from 2mm cylindrical bioglass material and cavities were restored according to research protocol. The samples were subjected to 2500 thermal cycles (5-55^{o}C), immersed in 0.5% basic fuchsin solution, embedded in epoxy resin and cut centrally and laterally (buccally or lingually) in a mesiodistal direction. Microleakage was scored and collected data were statistically analyzed using Kruskal-Wallis and Mann-Whitney tests.

Results: Minimal dye penetration was observed in the group that employed the incremental technique along with Scotchbond, with or without glass inserts. A significant difference was observed between the eight groups. In addition the use of the incremental technique and glass inserts had a significant effect on the microleakage of lateral and central sections, respectively. Application of dentin bonding agent significantly affected both sections.

Conclusion: Glass inserts were effective in decreasing cervical microleakage of class II cavities restored with composite resin.

Key Words: Composite Resins; Dental Leakage; Dental Restoration, Permanent; Dentin-Bonding Agents; Scotchbond Multi-Purpose

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INTRODUCTION

Light cure composite resins are being widely used for the restoration of posterior teeth. Several investigations have been conducted in order to analyze various features of photo-polymerized composites and subsequently improve their durability and physico-mechanical properties. A number of negative factors have been found to affect the success of posterior composite resin restorations such as polymerization shrinkage, polymerization depth, vector pattern of polymerization shrinkage, polymerization discrepancy between the surface and depth of the composite and more than 1mm distance between the light-cure unit tip and composite. Composite polymerization shrinkage can produce stress in the restored teeth and the material itself [1-3]. Shrinkage forces may cause clinical problems like postoperative pain, hypersensitivity, marginal breakdown and marginal opening with microleakage leading to secondary caries [4]. Causton et al [5] showed that forces developing during the polymerization of composites bonded to dental tissues can produce cuspal deformation in molars and premolars with MOD cavities.

Defective margins at the tooth-restoration interface can result from polymerization shrinkage following curing. Cervical microleakage is also caused by shrinkage, even when the restoration is completely bordered by enamel [6]. Several methods have been suggested to reduce these destructive factors such as the use of rebonding agents, retention grooves, acid etch, enamel bevel, incremental placement of filling material, application of glass ionomers and self-cure composites under light-cure composites, indirect resin inlay, dentin bonding agents, suitable polishing techniques and slow polymerization speed. It has been shown that none of these methods could completely eliminate microleakage. The utilization of glass inserts has been proposed in the last decade by a number of investigators to decrease polymerization shrinkage and microleakage.

The aim of the present study was to evaluate the effect of polymerization rate on the microleakage of class II composite resin restorations.

MATERIALS AND METHODS

Eighty extracted caries-free human first upper molars were selected for this in vitro study. Proximal cavities (class II boxes only) were prepared in the mesial surfaces by a No. 245 carbide bur mounted on a high-speed handpiece under copious air-water spray. The dimensions of the cavities in the gingival floor were as follows: mesiodistal width = 2mm, buccolingual length = 4mm, gingival floor = 1mm lower than CEJ. Because of mesial convexity of first upper molars, mesiodistal width of occlusal part of cavities was more than 2mm. All samples were randomly divided into eight groups of ten teeth each. Restoration methods and materials in each group are summarized in Table I.

Light conducting inserts were utilized in groups B, D, F and H. In these groups, cylindrical specimens two millimeters in diameter were fabricated from light transmitting bioglass material (Laab Mashhad Co. Mashhad, Iran). Coltene unfilled resin(Coltene Margin bond, Coltene AG Feldwiesnsetrasse, Switzerland) was used in groups A, B, E and F. Composite resin was polymerized as one complete unit in groups A and B, but was cured in 3 increments in groups E and F. The first layer was placed on the gingival floor with a thickness of 0.5 mm. The second and third layers were obliquely placed on the buccal and lingual walls, respectively. Each layer was light cured for 80 seconds.

Scotch bond multi purpose (3M Dental Products, St. Paul, MN) was used in groups C, D, G and H. Composite resin was polymerized as one complete unit in groups C and D, but was cured in 3 increments in groups G and H as explained before.

In groups B, D, F and H, etching of the inserts was performed with 9.5% hydrofluoric acid for 10 minutes and Scotchbond MP (3M Dental products, St. Paul, MN) was applied using the porcelain bonding system according to the manufacturer’s instructions.

Tofflemire matrices (no.1, Universal Matrix System, Tofflemire, USA) were placed and

Table I: Experimental groups and restoring methods.

Group	Restoration Technique	Bonding Agent	Glass Insert
A	One bulk	Coltene unfilled resin	No
B			Yes
C		Scotchbond multipurpose	No
D			Yes
E	Incremental	Coltene unfilled resin	No
F			Yes
G		Scotchbond multipurpose	No
H			Yes

cavities were restored using light cure A3 composite resin (Coltene Brilliant Dentin, Coltene AG Feldwiesnsetrasse, Switzerland). The filling material was light-cured for 80 seconds with a visible light curing unit (Coltolux 2.5, Coltene/Waledent Inc, Mahwah, NJ) from an occlusal direction.

All restorations were finished by means of a finishing carbide bur and polished utilizing the polishing Vivadent system (Ivoclar-Vivadent, Liechtenstein).

The teeth in each group were placed into separate mesh bags and subjected to 2500 thermal cycles between 5 and 55^{o}C with a dwell time of 30 seconds in each bath and a 15-second transfer time between baths. The external surface of each tooth was coated with two layers of nail varnish, leaving a 1 mm-wide margin around the restoration free of varnish. All teeth were immersed in a 0.5% basic fuchsin solution for 24 hours at 37 ^{o}C. This was followed by cutting the roots and embedding the specimens in epoxy resin (Ciba–Geigy, Maastricht, BV). All samples were sectioned twice in a mesiodistal direction, once in the center of the restoration and the other in the most buccal or lingual aspect of the filling (Fig. 1).

Dye penetration was examined with a stereo-microscope (SD/SF Series, Olympus Scientific Equipment Group, Japan; ×40 magnification)

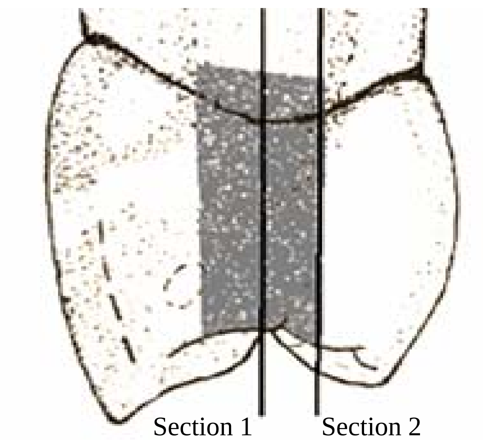

Fig 1: Schematic illustration of two sections.

and scored as follows: 0 = no penetration; 1= penetration less than half the gingival floor; 2 = dye penetration extending to the axial wall; 3 = dye penetration including the axial wall; 4= dye penetration towards the pulp.

Due to dye penetration problems, six of the samples were excluded from groups D, E and F (two from each group).Data were analyzed using Kruskal-Wallis and Mann-Whitney tests.

RESULTS

The frequency of each degree of microleakage in each study group is shown in Table II.

Significant differences were observed between the eight groups. Lateral sections showed that using the incremental technique significantly decreased microleakage ($P<0.02$). Lateral sections showed that using the light conducting inserts significantly decreased microleakage ($P<0.048$) and using the Scotchbond multi purpose significantly decreased microleakage in lateral sections ($P<0.001$).

DISCUSSION

According to stereomicroscope observations, dye absorption was different in each layer of composite restorations in teeth filled with the incremental technique without glass inserts (groups E and G). This indicates different degrees of polymerization and confirms Hellwig's theory stating that placing composites in multiple layers can cause differences in the degree of polymerization [7]. Reduced shrinkage may be due to the small bulk of material in each layer [7].

In spite of the fact that the incremental technique was also used in groups F and H, dye absorption was not different in each layer. This might be because of the light conductibility of the glass inserts used in these samples which is in accordance with the findings of Bagheri and Moazzami [8].

In groups B and D of the present investigation, dye absorption was similar in the composite resin near the gingival floor and occlusal surface. According to Fusayama [9], incremental placement of composite resin may lead to interlayer voids. However, Bagheri and Moazzami [8], Maitland [10] and Crispin [11] stated that the use of inserts produced more compact composites in the cavities and eliminated voids. Incremental placement of composite resins along with glass inserts was difficult to perform and voids were formed between the 2nd and 3rd layers, as was seen in groups F and H. In restoration of class II cavities, placing the spectral output of the curing unit close to the composite is impossible. Dental tissue or a matrix band could cause light to become opaque or shady. In addition illumination of light from behind a 2mm layer of composite resin can decrease the amount of transmission. According to Ruyter and Oysaed [12], placing the tip of a curing unit at a 2mm distance from a detector could cause a 7% decrease in output energy which could be further reduced to 25% when the distance is increased to 4mm. When restoring class II cavities, the marginal ridges and cusps usually demonstrate a distance of at least 4mm from the gingival floor. Therefore the exposure time should be increased in order to achieve maximum hardness and durability of the filling material. The recommended distance of a light source from the composite surface is 1mm. Various methods and instruments have been proposed to transmit light to inaccessible areas of the cavity such as transparent matrix strips, light conducting wedges, mirror matrix bands and transparent cones attached to the tip of the curing unit [13]. However, controlling the exact distance of the tip of a curing unit would be problematic in clinical settings. It has been shown that addition of inserts to composite resins can decrease their microleakage, which is duo to the lower thermal expansion coefficient of the inserts [14]. Donly et al also stated that glass inserts can increase the strength of composite resins [14].

According to Bowen et al [15], the use of glass inserts improves microleakage, stiffness, strength and durability of composites and also increases dental crown stability during curing and function. Rada [16] indicated that placement of glass inserts in composite resins not only is cost efficient and decreases the microleakage of restorations, but also improves their strength, proximal contour, contact and working time. Toni et al [17] showed a decrease in the depth of the wear of composite resins containing glass inserts.

In summary the advantages of glass ceramic inserts includes, displacement of composite volume with subsequent decrease in polymerization shrinkage; an overall improvement of the properties of restorations; minimizing curing increments; conduction of light to deeper areas of the restoration during curing as a result of their transparency; and condensation of adjacent composite resins [11].

The use of glass inserts has been shown to transmit light from the occlusal surface to the gingival floor and increase hardness, physical properties and restoration durability [8].

In the present investigation the least dye penetration and microleakage was noted in the study group in which Scothbond multipurpose dentin bonding agent were employed along

Table II: Frequency of each degree of microleakage in each study group.

Scoring	Section 1								Section 2							
	A	B	C	D	E	F	G	H	A	B	C	D	E	F	G	H
0	-	-	-	1	-	-	1	-	-	-	-	-	-	-	1	-
1	-	1	-	1	-	2	3	1	-	-	-	-	-	-	2	1
2	-	1	4	1	-	1	1	4	-	1	-	1	-	1	1	2
3	-	3	2	-	-	-	-	4	-	2	4		-	1	1	6
4	10	5	4	5	8	5	5	1	10	7	6	7	8	6	5	1

with light conducting inserts and incremental placement of the filling material. The reducetion of microleakage following application of composite resins with glass inserts has been shown in previous studies [18].

CONCLUSIONS

1. Samples restored with the incremental technique, using Scotchbond multipurpose system with glass inserts had the least dye penetration and microleakage.
2. Using dentin bonding agents along with incremental placement of composite resin and light conducting inserts can decrease microleakage in class II cavities below the CEJ.

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